THE TEAM

Arch. Student Team
- Architectural Design
- Construction Detailing

Bldg. Sci. Student Team
- Envelope Design
- MEP Design
- Energy Modeling

External Consultants
- BIM Model Oversight
- Project Management

Faculty Support Team
- Constructability
- Costing
- Design Review

THE HARVEST HOME
- Fire Station
- Urban Garden
- Place of Worship
- Restaurant & Bar
- Educational Facilities
- Gym & Fitness Center
- Arts & Entertainment Complex
- Employment and Office Centers
- Supermarket & Convenience Store

Area Plan - Existing
Design a cost-effective response allowing the average Denver family to purchase, operate and maintain a sustainable home.

Incorporate flexible interior and exterior spaces capable of accommodating a variety of familial scenarios.

Meet or exceed the requirements and standards outlined for certification by the Passive House Institute United States (PHIUS+).

Create a net-zero ready home with the potential of operating completely independent of municipal servicing.
Employ traditional construction methods coupled with readily available on-the-market materials, finishes, equipment and appliances.

Incorporate open concept space planning capable of hosting a variety of functions within the modest sized floor plate.

Design the building envelope to be air-tight and thermal bridge free throughout.

Consider the building as a direct derivative of the natural context allowing for rain water collection and optimal passive solar gains.
THE TEAM

Frontage at Lawrence Street
Row Elevation - North
Row Elevation - South
CONCEPTUAL MASSING

- Multi-Purpose Space
- Outdoor Living
- Circulation
- Living

Interconnected Floor Space

Central Stair

South Oriented Operable Glazing
CONCEPTUAL MASSING

Building Services

- Mechanical Room
- Washrooms
- Service Wall
- Mini-Split Unit
- Kitchen

Polar Shading & PV Orientation

- Solar Shading
- Photovoltaic Ready
- Solar Shading
Building Axonometric
Floor Plan - Level Two
Floor Plan - Level Three
Unit Elevation - North

Unit Elevation - South
THE FLEXIBLE WORKSPACE

Centralized Island  Peninsula Counter  Work Surface Extension
ENVELOPE DESIGN STRATEGIES

- Eliminate thermal bridging across the entire envelope through external insulation.
- Ensure an air tight envelope to limit undesired air infiltration.
- Employ a rain screen approach to drain bulk water and ventilate envelope layers.
- Control solar gains through optimized glazing distribution.
- Design envelope to be highly durable using simplistic construction materials and methods.
- Optimize interior thermal comfort through appropriate insulation and air sealing details.
ENVELOPE ASSEMBLIES

**Vertical Wall Assembly (R-44)**
- Fibre Cement “Ecoclad” Panel
- 1” Air Cavity
- Tyvek Weather Barrier
- 2 Layers - 3” Roxul Rigid Insulation (R-25.8)
- 1/2” Zip System Air Barrier / Vapor Retarder
- 2 x 6” Structural Stud Wall (16” O/C)
- 5-1/2” Blown Cellulose Insulation (R-21)
- 1/2” Gypsum Wall Board
- Zero VOC Paint Finish

**Roof Assembly (R-56)**
- Standing Seam Metal Roof
- 1” Air Cavity
- 2 Layers - 15lb. Roofing Felt
- 5/8” Plywood Sheathing
- EPS Rigid Insulation (R-20)
- 1/2” Plywood Sheathing
- 2 x 10” Wood Joists (16” O/C)
- 9-1/2” Blown Cellulose Insulation (R-33.25)
- 1/2” Zip System Air Barrier / Vapor Retarder
- 1” Wood Furring
- 5/8” Gypsum Wall Board Type X
- Zero VOC Paint Finish
HYGROTHERMAL ANALYSIS

Exterior Sheathing Moisture Content

Exterior Sheathing Temperature & Relative Humidity
AIR INFILTRATION
 Triple Glazed Alpen 725 Series Door
Wood Framed Terrace Canopy
Ensure Continuous Air Barrier
Galv. Metal Threshold Drain Pan

Section Detail - Third Level Terrace Door
INDOOR AIR QUALITY & VENTILATION STRATEGIES

- Eliminate airborne pollutants within through exceptional filtration of circulated and fresh air supply.
- Incorporate mechanical ventilation systems to circulate and ventilate interior air.
- Minimize noise generation and travel throughout the home.
- Reduce, drain and control moisture within the building envelope.
- Specify materials and finishes with low volatile organic compounds (VOCs).
- Control supply and exhaust air to and from the home to ensure superior quality interior air.
- Mitigate radon infiltration from surrounding soil.
Space Conditioning Strategies

- Appropriately size the mechanical system to meet the volumetric heating requirements.
- Minimize operational costs throughout the mechanical system’s entire life cycle.
- Employ a consistent energy supply source throughout all home systems.
- Minimize residual heat loss in duct runs and exhaust air.
Thermal Comfort with Appropriately Sized System
Minimize Capital Operating Costs
Ecologically Conscience Energy Source
Control Supply and Exhaust
Minimize Heat Loss
Maintain Healthy Air

Mitsubishi Mini-Split Heat Pump

Ventilation Ductwork

Supply Air

Exhaust Air

UltimateAir RecoupAerator ERV

Condensing Unit
DOMESTIC HOT WATER STRATEGIES

- Utilize the same energy source as the HVAC system.
- Minimize operational costs throughout the mechanical system’s entire life cycle.
- Eliminate the potential for standing water heat loss.
Thermal Comfort with Appropriately Sized System

Minimize Capital Operating Costs

Ecologically Conscience Energy Source

Control Supply and Exhaust

Minimize Heat Loss

Maintain Healthy Air
**ELECTRICAL, LIGHTING & APPLIANCE STRATEGIES**

- Specify high efficiency fixtures and equipment to reduce annual energy consumption.

- Minimize operational costs throughout the mechanical system’s entire life cycle.

- Specify compact appliances and equipment to alleviate space within the modest floor plate.

- Maximize daylighting potential through the use of solar optimized glazing distribution.
**Thermal Comfort with Appropriately Sized System**

- Minimize Capital Operating Costs
- Ecologically Conscience Energy Source
- Control Supply and Exhaust
- Minimize Heat Loss
- Maintain Healthy Air

---

**Context**

- **Dining Room / Kitchen**
- **Living Room**
- **Pantry**
- **Entry CL**
- **Adjoining Unit**

**Design Goals**

- MEP
- RENewableS
- IAQ
- Financial
- Summary

**The Team**

- **MEP**
- **RENewableS**
- **IAQ**
- **Financial**
- **Summary**

**Proposal**

- **Envelope**

**Electrical Plan - Level One**

- **LED Pot Lighting**
- **Master On/Off Switch**
- **Compact Refrigerator**
- **Built-in Oven & Cooktop**
- **Task Lighting**

**Electrical Plan - Level Two**

- **LED Pot Lighting**
- **Master On/Off Switch**
- **Compact Refrigerator**
- **Built-in Oven & Cooktop**
- **Task Lighting**
- **Stacked Washer & Dryer**
- **Shading Structure**

**Electrical Plan - Level Three**

- **LED Pot Lighting**
- **Master On/Off Switch**
- **Compact Refrigerator**
- **Built-in Oven & Cooktop**
- **Task Lighting**
- **Stacked Washer & Dryer**
- **Shading Structure**
- **South Terrace Glazing**
KITCHEN APPLIANCES

Moffat Compact Refrigerator 389 kWh/yr
Blomberg Concealed Dishwasher 210 kWh/yr
Miele Cooktop 235 kWh/yr
Zephyr Savona Rangehood
Whirlpool Oven (Built-in) 197 kWh/yr

Annual Primary Energy Consumption
36.1 kWh/m² - yr
Passive House Recommended 50.0 kWh/m² - yr
DAYLIGHTING & SHADING STRATEGY

Solar Optimized Shading Canopies

Summer Sun

Winter Sun
### PHOTOVOLTAIC INTEGRATION

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Energy Consumption</td>
<td>3,800 kWh/yr</td>
</tr>
<tr>
<td>Total Energy Generation</td>
<td>3,010 kWh/yr</td>
</tr>
<tr>
<td>Total PV Capacity</td>
<td>2.4 kW</td>
</tr>
<tr>
<td>Gross Cost (Incl. Install &amp; Tax Credit)</td>
<td>$7,622</td>
</tr>
<tr>
<td>Pay Back Period</td>
<td>10 yrs</td>
</tr>
<tr>
<td>Net Cash Flow - 25 yrs</td>
<td>$15,500</td>
</tr>
</tbody>
</table>

- Photovoltaic Panels - 8 @ 77" x 40"
- Backup Generator
- Flat Roof
- Terrace
- Back Yard
- Front Yard
- Sloped Roof

---

**HARVEST HOME | RU**
## AFFORDABILITY ANALYSIS - PITIU METHOD

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal + Interest</td>
<td>$1,467.94  / $17,615.28 /yr</td>
</tr>
<tr>
<td>Taxes (Property)</td>
<td>$2,250 /yr</td>
</tr>
<tr>
<td>Insurance</td>
<td>$1,875 /yr</td>
</tr>
<tr>
<td>Utilities</td>
<td>$632 /yr</td>
</tr>
<tr>
<td>Debt Repayment</td>
<td>$375 /yr</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$24,597 /yr</strong></td>
</tr>
</tbody>
</table>
AFFORDABILITY ANALYSIS - ANNUAL HOUSING EXPENSES

Median Family Income (MFI)  
City of Denver  
$75,000

Typical Housing Expenses (33%)  
$25,000 /yr

Harvest Home  
$24,597 /yr

Critical Components Replaced Twice in 30 years  
$403 Net Annual Cash Flow
RATING SYSTEMS

Passive House Institute US

REM/Rate

U.S. Green Building Council

LEED

USGBC
## THE PASSIVE HOUSE STANDARD

<table>
<thead>
<tr>
<th></th>
<th>Heat Demand</th>
<th>Cooling Demand</th>
<th>Primary Energy Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive House Standard</td>
<td>4.75</td>
<td>4.75</td>
<td>38</td>
</tr>
<tr>
<td>Harvest Home</td>
<td>2.4</td>
<td>1.74</td>
<td>37.82</td>
</tr>
</tbody>
</table>
HERS RATING - REM/RATE SOFTWARE

Harvest Home - Initial Construction

Harvest Home - On-site Photovoltaic Panels
<table>
<thead>
<tr>
<th>Category</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation &amp; Design Process</td>
<td>6</td>
</tr>
<tr>
<td>Location &amp; Linkages</td>
<td>7</td>
</tr>
<tr>
<td>Sustainable Sites</td>
<td>17</td>
</tr>
<tr>
<td>Water Efficiency</td>
<td>14</td>
</tr>
<tr>
<td>Energy &amp; Atmosphere</td>
<td>28</td>
</tr>
<tr>
<td>Materials &amp; Resources</td>
<td>10</td>
</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>8</td>
</tr>
<tr>
<td>Awareness &amp; Education</td>
<td>1</td>
</tr>
</tbody>
</table>
LEED FOR HOMES

Innovation & Design Process 6
Location & Linkages 7
Sustainable Sites 17
Water Efficiency 14
Energy & Atmosphere 28
Materials & Resources 10
Indoor Environmental Quality 8
Awareness & Education 1

TOTAL 91 Points

THE HARVEST HOME

37 Points Certified
52 Points LEED Silver
67 Points LEED Gold
82 Points LEED Platinum
<table>
<thead>
<tr>
<th></th>
<th>AVERAGE COLORADO RESIDENCE</th>
<th>THE HARVEST HOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>HERS Rating</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>Passive House U.S.</td>
<td>N/A</td>
<td>Certified</td>
</tr>
<tr>
<td>LEED Certification</td>
<td>N/A</td>
<td>Platinum - 91 pts</td>
</tr>
<tr>
<td>Annual Energy Consumption</td>
<td>102,000 kBTU/yr</td>
<td>23,600 kBTU/yr</td>
</tr>
<tr>
<td>Annual Heating + Cooling Cost</td>
<td>$1,551 /yr</td>
<td>$632 /yr</td>
</tr>
<tr>
<td>Gross Area</td>
<td>2,082 sf</td>
<td>1,175 sf</td>
</tr>
<tr>
<td>Construction Cost / ft²</td>
<td>$120 - $300 /sf</td>
<td>$146 /sf</td>
</tr>
</tbody>
</table>